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United States
Department of
Agriculture

Forest Service



International Institute
of Tropical Forestry

Research Map
IITF-RMAP-06

November 2008



Landscape units of Puerto Rico: Influence of climate, substrate, and topography

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English and Spanish version enclosed

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The enclosed map was developed by the Puerto Rico Gap Analysis Project (PRGAP) and displays variation in the landscape related to climate, substrate, and topography. We have defined a set of 57 distinct landscape units by integrating six climatic zones (Holdridge lifezones), six geologic substrates, and five topographic positions. The map was developed for the purpose of understanding and modeling variation in vegetation. The map presents a set of ecologically distinct units and can serve as a tool for stratifying the landscape for assessing variation in ecosystem attributes and services.

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Unidades del Paisaje de Puerto Rico: La influencia del clima, el substrato, y la topografía

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Proyecto de Análisis Gap de Puerto Rico
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Descripción del mapa

El mapa de unidades del paisaje de Puerto Rico representa variaciones climáticas, topográficas y del substrato mediante la integración de seis zonas climáticas (Ewel y Whitmore, 1973), seis substratos (Bawiec, 2001; USGS, 2005), cinco posiciones topográficas, o topofomas (Martinuzzi et al. 2007), y cuerpos de agua (USGS 2005). Los substratos representan el conjunto simplificado creado por Bawiec (2001) compuesto por doce unidades de terrenos geológicos. Estos terrenos están clasificados en: depósitos de roca caliza del cretáceo y terciario, depósitos de aluvión y otros depósitos no consolidados del cuaternario, formaciones volcánicas intrusivas y extrusivas y depósitos sedimentarios volcánicos (sedimentos de origen volcánico – pueden o no ser calcáreos), y formaciones de serpentina ultramáfica y anfibolito (bajo contenido de cuarzo, de pH típicamente alto). También se delinearon humedales salinos y no salinos (USGS 2005). El mapa resultante presenta 57 unidades del paisaje para las islas. El mismo fue desarrollado para el estudio y modelaje de la variación en la vegetación. La variación natural de la vegetación presenta una jerarquía de controles ambientales que incluyen clima, geoquímica de los substratos, topografía, y disturbios. La información geoespacial de estos controles es útil para modelar la variación de la cobertura vegetativa y las propiedades de los ecosistemas asociados. Este mapa parte de trabajos previos por Figueroa (1996) para desarrollar un mapa de geoclima de Puerto Rico.

- Los controles climáticos incluyen el rango, la media, y la variabilidad de temperaturas del aire y precipitación regulada por gradientes latitudinales, patrones atmosféricos globales, patrones orográficos, y retroalimentación con la cobertura del terreno (Chapin et al. 2005).
- Las características del substrato (geoquímica) incluyen pH del suelo, disponibilidad de nutrientes, y textura, los cuales afectan fuertemente la composición de especies de plantas (Gould et al. 2006). La geoquímica esta relacionada a roca expuesta, depósitos cuaternarios, historia del uso del terreno, y procesos biológicos.
- La topografía afecta la composición de especies de plantas influyendo la humedad del suelo, desarrollo, textura, y química (Birkeland 1984). La posición de la pendiente esta también relacionada a disturbios. Topofomas particulares pueden estar influenciadas por inundaciones, tormentas, derrumbes, fuego, o disturbios antropogénicos.

Las topofomas más abundantes en Puerto Rico son las pendientes húmedas y muy húmedas en substratos volcánicos de la Cordillera Central y Sierra de Luquillo, las cuales representan 40% de la superficie de la isla. Pendientes húmedas y muy húmedas en substratos de caliza representan un 10% de la superficie. Lomas y pendientes secas representan un 6%, con 30% de las mismas en roca caliza, y el resto (70%) en substratos volcánicos y serpentina ultramáfica. Cerca del 12% del paisaje esta formado por aristas, del cual 90% están localizadas en regiones climáticas húmedas y muy húmedas. Los llanos húmedos representan un 16% y los llanos secos un 8% de la isla. Los humedales y las depresiones, sin incluir cuerpos de agua abiertos, representan un 5% de la superficie isla, 70% de los cuales cuentan con un clima húmedo y 30% con un clima seco.



Clima (Zonas de vida de Holdridge)

Unidades del paisaje

Estos datos son resultado de la integración de datos geoespaciales sobre topofomas y regiones geoquímicas de Puerto Rico. Se derivaron 57 unidades del paisaje, incluyendo agua y cuatro tipos de humedales.

Topofomas

Las topofomas incluyen cinco posiciones de pendiente, modeladas utilizando elevación y topografo (Martinuzzi et al. 2007).

Clima y substrato

Las dieciséis regiones geoquímicas integran información de clima y geología utilizando las zonas de vida de Holdridge (Ewel and Whitmore 1973) y la geología de Puerto Rico creada por el Servicio Geológico de E.E.U.U.

| Clima | Caliza | Aluvial y cuaternaria no consolidada | Ultramáfica ignea | Volcánica y volcánica/terciaria | Substrato | |
|--------------------------------|-----------------|--------------------------------------|-------------------|---------------------------------|-------------------------|-----------------|
| | | | | | Cresta | Pendiente alta |
| Bosque seco subtropical | | | | | Pendiente media | Pendiente media |
| | Cresta | Pendiente alta | Cresta | Cresta | Pendiente media | Pendiente media |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | Pendiente media | Pendiente media |
| | Llano | Llano | Llano | Llano | Llano | Llano |
| Bosque húmedo subtropical | | | | | | |
| | Cresta | Pendiente alta | Cresta | Cresta | Humedales y depresiones | Humedo salino |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | Pendiente media | Pendiente media |
| | Llano | Llano | Llano | Llano | Llano | Llano |
| Bosque muy húmedo subtropical | | | | | | |
| | Cresta | Pendiente alta | Cresta | Cresta | | |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | | |
| | Llano | Llano | Llano | Llano | | |
| Bosque pluvial subtropical | | | | | | |
| | Cresta | Pendiente alta | Cresta | Cresta | | |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | | |
| | Llano | Llano | Llano | Llano | | |
| Bosque muy húmedo montano bajo | | | | | | |
| | Cresta | Pendiente alta | Cresta | Cresta | | |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | | |
| | Llano | Llano | Llano | Llano | | |
| Bosque pluvial montano bajo | | | | | | |
| | Cresta | Pendiente alta | Cresta | Cresta | | |
| | Pendiente media | Pendiente media | Pendiente media | Pendiente media | | |
| | Llano | Llano | Llano | Llano | | |

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Encuestas adicionales de datos: Centros urbanos: Los centros urbanos fueron desarrollados por el Laboratorio de SIG y Teledetección del Instituto Internacional de Dasonomía Tropical mediante la interpretación visual de mapas existentes. Cada punto representa la localización aproximada del centro urbano de cada municipio.

Datos hidrográficos: Los datos hidrográficos fueron derivados y generalizados de los datos del National Hydrography Dataset (NHD). El NHD fue creado por el U.S. Geological Survey en cooperación con el U.S. Environmental Protection Agency, US Forest Service, y otras agencias estatales y federales así como colaboradores locales. 2005, Reston, Virginia. Estos datos son presentados en formato vector, generalmente descargados a una escala de 1:24 000/1:12 000.

Geología: Los datos geológicos fueron derivados y generalizados de los datos Terrrenos geológicos de Puerto Rico (Bawiec 2001).

Topofomas: Gould, W.A.; Martinuzzi, S.; Jiménez, M.E.; Edwards, B.R.; Ramos-González, O.M. 2008. Topographic units of Puerto Rico. Scale 1: 260 000. IITF-RMAP-04. Rio Piedras, PR. US Department of Agriculture Forest Service, International Institute of Tropical Forestry.

Zonas climáticas: Modificadas de Ewel y Whitmore 1973.

Clima original: Gould, W.A.; Jiménez, M.E.; Potts, G.S.; Quiñones, M.; Martinuzzi, S. 2008. Landscape units of Puerto Rico: Influence of climate, substrate, and topography. Scale 1: 260 000. IITF-RMAP-06. Rio Piedras, PR. US Department of Agriculture Forest Service, International Institute of Tropical Forestry. (Spanish version)

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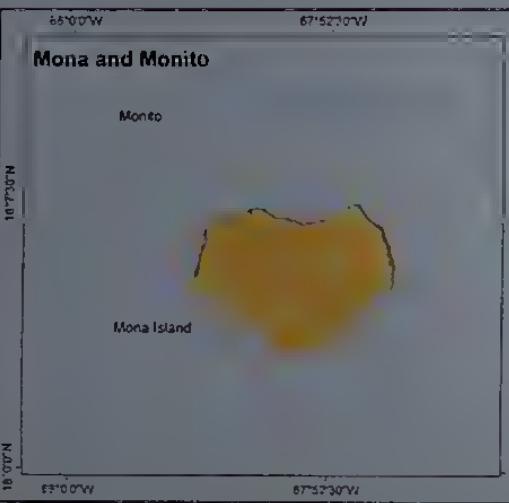
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PRGAP ANALYSIS PROJECT
IITF GIS and Remote Sensing Lab
A center for tropical landscape analysis



Map description

The landscape units map of Puerto Rico represents climatic, substrate, and topographic variation by integrating six climatic zones (Ewel and Whitmore 1973), six distinct substrates (Bawiec 2001, USGS 2005), five topographic positions or landforms (Martínez et al. 2007), and prominent lakes and rivers (USGS 2005). Substrates were a simplified set of Bawiec's (2001) twelve geologic terrane units and include cretaceous and tertiary limestone deposits, alluvium and other unconsolidated quaternary deposits, intrusive and extrusive volcanic formations and volcanoclastic sedimentary deposits (reworked sediments of volcanic origin – may or may not be calcareous), and ultramafic serpentine and amphibolite formations (low quartz content – typically high pH). We also delineated saline and nonsaline wetlands (USGS 2005). The resulting map displays a set of 57 landscape units for the islands. The map builds on earlier work by Figueiroa (1996) mapping geoclimatic variation in Puerto Rico and was developed for the purpose of understanding and modeling variation in vegetation. Natural variation in vegetation has a hierarchy of environmental controls, including climate, geochemical substrates, topography, and disturbance. Geospatial information on these controls is useful for modeling potential variation in vegetation cover and associated ecosystem properties.

- Climatic controls include the range, mean, and variability of air temperatures and precipitation regulated by latitudinal gradients, global atmospheric patterns, orographic patterns, and feedbacks with landcover (Chapin et al. 2005).
- Substrate characteristics (geochemistry) include soil pH, nutrient availability, and texture, which strongly affect plant species composition (Gould et al. 2006). Geochemistry is related to exposed bedrock, quaternary deposits, land use history, and biological processes.
- Topography affects plant species composition by influencing soil moisture, development, texture, and chemistry (Birkeland 1984). Slope position is also related to disturbance and particular landforms may be more or less influenced by flooding, storms, landslides, fire, or human development.

The most abundant landforms in Puerto Rico are the moist and wet slopes on volcanic substrates of the Central and Luquillo Mountains, which include 40% of the area. Moist and wet slopes on limestone substrates make up 10% of the area. Dry hills and slopes make up 6% of the area, with 30% of these on limestone and the remaining 70% on volcanic and ultramafic serpentine substrates. Nearly 12% of the landscape is made up of ridges and 90% of these are in the moist and wet climatic regions. Moist plains include 16% of the area and dry plains include 8% of the area. Wetlands and depressions, not including open water bodies, make up 5% of the area. Nearly 70% of these are in moist climatic regions and just under 30% in dry climatic regions.



Climate (Holdridge lifezones)

| Landscape units | Slope positions | Climate and substrate |
|--|--|--|
| This dataset is the result of the integration of geospatial data on landforms and geoclimate regions of Puerto Rico. We derived 57 classes including water and four types of wetlands. | The landforms dataset includes five slope positions modeled using elevation and topography (Martínez et al. 2007). | Sixteen geoclimatic regions integrate climate and geologic information using Holdridge's lifezones (Ewel and Whitmore 1973) and the USGS (Bawiec 2001) geology of Puerto Rico. |
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Substrate

| Limestone | Alluvial and unconsolidated quaternary | Ultramafic igneous | Volcanic and volcanoclastic |
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